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FUNCTIONS OF AN ECOLOGICAL SOCIETY[1]

By Professor R. E. COKER
UNIVERSITY OF NORTH CAROLINA

PERHAPS you know that there are two chief reasons for a presidential address, reasons that most people are too polite to mention. One is the gracious desire to flatter the president by making him think he is expected to have something to say that will be interesting or instructive to the members, which may or may not be the case at all; the other is to let people know who is the president. When a man is elected to the presidency of a national society he enjoys justifiably a feeling of great pride; he may even experience a degree of inflation, but that soon subsides as he learns that few know and even fewer care who is president. In a country school near my old home, there was a boy well along in the grades who did not know who was the chief executive officer of the United States. The teacher, wanting to shame or to impress him, told him to go home and ask his father. The boy went and returned. "Well, Johnny," said the teacher, "did your father tell you who was president?" Johnny arose with an obviously triumphant air, as he replied, "I axed paw and he don't know." Johnny was destined to become a political orator with a flair for the dramatic. He indulged in a rhetorical pause before he added: "Paw don't know who is President—and what's more, he don't give a damn!"

Early in the year some friends intimated that perhaps the society would be pleased if I should bring to an end the practice of having annual presidential addresses. In acceptance of this challenge, I seemed to have two choices: one was to allow the custom to lapse forthwith; the other was to deliver an address to end all presidential addresses. It occurred to me that I might do both. The matter to follow, then, will probably not meet the specifications of a presidential address and it may lead to a conclusion that will discourage the desire, at least, for future addresses of a

[1] Address delivered by the president of the Ecological Society of America at the annual dinner in Indianapolis, December 28, 1937.

similar nature. Actually, I am attempting to open a practical discussion of the significance and function of the Ecological Society of America.

It is appropriate to ask in the first place—What is the historical significance of scientific societies? We are not bound by history, but we are the more liable to make mistakes if we ignore it. It is a fact, I believe, that, taking into view the whole history of modern science, the scientific societies have played a part in its development second to no other agency. Camac, in a study of medical history ("Imhotep to Harvey"), is my authority for the statement that at a time when the universities, dominated by philosophy and theology, were thoroughly inimical to the sprouting natural sciences it was a new type of institution, coming into being in the seventeenth century, that more than the universities stimulated and made possible the birth and growth of modern science. It was not long, of course, before the universities found it necessary to fall into line and they became for a time, at least, the nestors of the new disciplines. I doubt, however, if the scientific societies have ever given up their leading part in the guidance of scientific development. Was it Harvard or Yale or Virginia that kept the light of science in this country before the middle of the last century, or was it the American Philosophical Society (1727), the Charleston Museum (1773), the American Academy of Arts and Sciences (1780), the Academy of Natural Sciences in Philadelphia (1812), the Lyceum of Natural History in Albany (1817), the Boston Society of Natural History (1830), the American Medical Association (1847), and other organizations in which those with the research spirit had voluntarily associated themselves? Give credit to both universities and societies, but the latter, we know, played a great part. I am inclined to wonder now if there is not occurring a shift of responsibility in an entirely new direction, if the shaping of scientific progress is not a task that is being assumed more and more, although quite unintentionally, by the new type of agency that we call "foundations." What present-day science owes to individual and corporate Maecenas may readily be conceived if we stop to ask what would be the state of advancement of science in all fields, had we not had the laboratories, the observatories, the fellowships, the grants-in-aid, etc., contributed from private or semi-private sources, as contrasted with the facilities derived from government aid or from the private resources of students and research workers. The foundations operate to some extent independently and also in very considerable measure through existing research institutions, such as the universities. It is quite possible, however, for universities to lose their position of partial dominance, not so much through the imposition of an outside will, as through the temptation to develop their departments and activities in ways that will appeal to those who can grant support. Throughout all the changes that have occurred, the influence of the voluntary associations of the workers in science has remained, and, it is to be hoped, will always remain, an unobtrusive but none the less powerful influence in the molding of the science of the future.

Not infrequently the foundations, or persons of wealth, or even government departments, look to the National Research Council for suggestion and guidance in the use of funds to support scientific research. And what is the National Research Council but a body so organized as to represent the national scientific societies? Of all the 26 members of its Division of Biology and Agriculture, only 3 or 4 are not actually elected representatives of scientific societies and those 3 or 4 are elected by the representatives of the societies. It is a representative body and its merit is derived from its representative nature.

I hold it then to be, not only a moral responsibility of the several national scientific societies, but also an inescapable obligation, that they should strongly and wisely exercise guidance over the advancement of science in general and in every special direction in which its field of exploration should be extended.

Let me quote the following from the address of Dr. Edward R. Weidlein, president of the American Chemical Society, delivered in Rochester recently. "Fifty years ago, Europe led the world, chemically speaking. Far-seeing men predicted even then that in another half-turn of the century the chemical leadership of the world would pass to America. This change has come about, and the American Chemical Society as an organization deserves a large share of the credit."[2]

As vistas open in one point of the compass or another, new organizations of scientific workers, new societies, will come into being. When I consider that there were only 181 scientific and technical societies in the United States when I was born and that now there are nearly 1,000 (930),[3] I am moved to reflection. From that great surge of activity in scientific research and organization, which has accompanied my fleet passage through time, I derive a certain satisfaction in having been born; others may experience a different feeling, but there are some in this company who have an even worse record than I have.

The birth of new societies is not to be deplored; on the contrary, it is a desirable and necessary consequence as the number of workers grows and the breadth of the visible horizon of science steadily in-

[2] Edward R. Weidlein, SCIENCE, 86: 2229, 249–255, 1937.

[3] I am indebted to Miss Callie Hull, librarian of the National Research Council, for these interesting figures.

creases. The well-nourished tree continually branches out with new twigs, each of which is expected in due season to bear its fruit. That is a sign of health and an indication that the day of senescence is not yet at hand. I believe, however, that the new limbs and the new twigs should not become so nearly disconnected from the main trunk that they cease to exert a combined effort in drawing nourishment from the common soil while at the same time contributing more effectively to the health and growth of the other twigs derived from the same trunk. You will see that I mean to put some emphasis on the necessity of a healthier and stronger bond between the twigs. To put the same idea into ecological terms, we need to bind our biological individuals and species into communities and our communities into associations. To return to the tree simile—we have in the American Association for the Advancement of Science a great scientific trunk with its chemical, physical, geological and biological limbs. The chemical and geological limbs, for example, are healthy stock through which streams of intellectual and financial nourishment may flow to the outermost twigs. The biological limb, except for the medical branch, seems now to be little more than a loose aggregation of twigs, each trying to live for itself on the materials available in the free air. Whether we will or no, I think we shall be driven to the formation of a more effective general organization of all biologists. We have, to a very great extent, common interests and common needs and we should put ourselves in position to satisfy those needs and to protect those common interests, without sacrifice, but rather with promotion of the special needs and interests of the smaller component groups.

To return to the original question, what are the functions of the Ecological Society? We have already supplied one answer. It has to play, along with other national societies, a leading part in the development of the biological sciences of the future, *not by any form of control,* and I would underscore those words, but by serving as an open forum for free discussion and democratic expression of opinion, with the assurance that where people who actually work, habitually think and sincerely strive to render public service—where such people get together, exchange information and ideas, advance suggestions and subject their own half-baked or even wholly baked ideas to the fire of comment and constructive criticism, there something in the nature of emergent evolution takes place: the efforts of each and of all combined are lifted to higher and more effective levels. But what, more concretely, are the specific functions of the Ecological Society of America?

(1) In the first place, this society aims to promote ecological research. How?

(a) It stimulates research through meetings for the presentation of papers with discussion and criticism. I do not think that our meetings, or those of any other scientific group, are ideal for the accomplishment of this end. There are now so many workers in most of the broad divisions of the general biological field that meetings seem to tend more and more to become formal clock-controlled affairs for the concise, if not hasty presentation, of the results of research, with a minimum of discussion. I have, however, no suggestion to offer, and I am sure that the program meetings of this society rank with the best in the respect in question.

(b) Our society has also set a precedent in having regular field meetings. Dr. Shelford, last year, emphasized most properly one of the original functions in the minds of Drs. Wolcott, Harshberger, Cowles, Shelford and other founders. I say we have set a precedent, meaning among biological societies. Geologists have long had such meetings, but they are rare among national biological organizations, and it is natural that this should be so. Ecology, in contrast to other divisions of biological science, is concerned not so much with the particular plant or animal or part of a plant or animal, as it looks or behaves in the laboratory, but rather with organisms as they actually live and engage in the battle for existence among others in the real world. We are concerned with the work of individuals or of species in groups; and these groups, from the ecological point of view, are not mere summations or aggregations of unrelated individuals like the several beans in a bushel, but really display some sort of organization in which individuals or species are but minor or major units of function. The ecologist is concerned with the structure and activities of these larger organizations—that is to say, with the composition and the conditions of maintenance and operation of communities. I wonder sometimes that people compare communities to organisms or give them the sort of individuality which in our minds is associated with organisms, which after all, are mere short-lived sidelines from the continuous stream of life. Communities are more like molecules of protoplasm as we envision them; they are dependent upon one another; they continually change, but they persist; they evolve, but they come to no end except from outside causes.

(c) It is a further function or sub-function of the society to aid in the publication of the results of ecological research, both as a means of encouraging such investigative efforts and as the very condition of the effectiveness of research. We have now two good journals which are made available to members of the society and to others at a remarkably low cost. When I speak of the ecological journals as good ones

I am not merely scattering pleasant words. Both journals are surely capable of improvement—what undertakings are not?—but they call for no apologies.

The society, then, promotes ecological research through annual meetings for the presentation of papers, through additional mid-year meetings, through field excursions and through its research journals. This broad function thus served in several ways must, I am sure, be rated as paramount. Were this function to be neglected or abandoned, the Ecological Society of America could become little more than a social or commercial club, or a group of salesmen with little of evident value to sell. If only this one task be performed, the society justifies its existence; it holds its part as one of the significant scientific societies of the world. It lends dignity to a science that we must admit is relatively new, that is very inadequately matured and that has been so generally and so unfortunately unappreciated that it has too frequently seemed to lack the Divine Aura which other groups emanate, at least to their own olfactory sense. Ecology is immature as yet, but we believe in it or we would neither be here nor pay our dues. If ecology is not just at this moment commanding the eager interest of the non-ecological public, enraptured with protons and cell membranes and viruses, etc., that does not matter. It is a living science and it is concerned with absolute fundamentals. An organism can not do without cell membranes, without protein molecules, without genes, or something of that nature; but just as certainly it can not exist, it can not offer the slightest manifestation of life, without an environment. Protoplasm is only *part* of the physical basis of life. No organism lives, moves or has its being except as part of a complex of organisms and in connection with the so-called outside world. Actually, it was what would now be called ecological research that played a primary part in the development of the doctrine of the evolution of species by natural selection, promulgated simultaneously by two pre-ecological ecologists. This doctrine may not have been entirely correct, and no scientific doctrine is, but it established, nevertheless, the principle of evolution as a mode of operation in nature, and incidentally revolutionized thought in a dozen subjects. More recently ecology has established principles of succession, of interdependencies of organisms, of interrelations of organisms and environment, of cycles and niches, that can be ignored neither in the application of biological knowledge to human welfare nor in the scientific presentation of the fundamentals of biological thought. As to what this branch of science may do in the future, we make no prophecy; the ecologist simply does what he enjoys and finds stimulating and satisfying, as does the biophysicist or the geneticist. Whence will come the next great idea only the gods can tell. We are not the gods, nor among those who assume to know just where the seed of the solution of the mystery of life is soon to shoot, bud and burst into flower.

I say, then, not because there seems to be any special need to say it, but rather in order properly to round out our presentation of this primary function of the society, that it is our first duty to maintain and elevate to the very best of our abilities the standards of ecological research.

(2) The society has also an educational function.

(a) All scientific societies are educational. We have mentioned scientific meetings as promoting research; most of us, however, come to these meetings not so much to stimulate research on the part of our fellows (although our presence may sometimes have such an effect upon them as well as upon ourselves) as to learn, to acquire information and ideas, not only as an aid to our own researches but for our own educational profit. We tell our students that education only begins in college and that self-education is a continuing process. That is really true, and it supplies a major reason for attendance on scientific meetings. Let us note, furthermore, that the educational function of the society is at least a threefold one.

(b) That we educate ourselves and each other is very important, but we need to do much more, and we are perhaps making some progress in the other directions. It is necessary to educate those in other fields of science as to the meaning, the value and the absolute necessity of ecological research.

The ecologist need not forget that he is vulnerable. He deals with things in the large, attacking a whole complex at one time. He knows that certain fundamental biological phenomena manifest themselves only in the large. Some one has to face such problems, and he goes after them and gets results. It is easy and perhaps not unnatural for the outsider to criticize, to say: you have not set up an experiment under the strictest conditions of control. Your only answer is that you know it, but you are going ahead just the same. The physiologist and the morphologist say to the ecologist: yours is not an exact science; and that is true. The physicist says to the physiologist or the morphologist: yours is not an exact science; and that is also true. The mathematical physicist says that physics is not really an exact science; and that seems to be true, too. The only thing left in the nature of an exact science is statistics, a branch of mathematics, which happens not to be a science at all. Mathematics is the tool of science and ecologists can employ it just as well, perhaps better, than morphologists or physiologists. In fact, in my limited vision, communities are like molecules in being statistical entities; but I will not stress that point now.

Undoubtedly, something yet remains to be done in the education of biologists in general, in respect to the value of ecological research and teaching if the biological training of present and coming generations of students is to be properly carried out. Like all special divisions of biological science, ecology tends to develop a language of its own, a jargon, if you will, that may be somewhat discouraging to those whose training is in other fields. As more knowledge is gained and as the science matures, the translation of essentials into ordinary language becomes a normal part of the procedure. In any event, a properly balanced program in the teaching of biology requires that we keep always in mind that the field of organization is not bounded by the cell membranes, by the sheath about the organ or by the epidermis of the individual, and that community life is as much a basic condition of organic existence as is protoplasm.

Just a few months ago the head of a department of biology, a man whose special interest in research is far removed from ecology, told me that he had set out to find a man to teach comparative anatomy and he must have some one with a degree of ecological training. Comparative anatomy was what the administration of the institution would provide for, but he personally was convinced that they must get away from the presentation of introductory zoology as pure morphology and organ physiology and must introduce the students in some way to the principles of ecology, to the conditions governing the community relations of animals and plants in nature. This particular illustration is merely one indication that progress has been made toward providing that more consideration be given in the future than has been given in the past to the organism as it actually lives *at home* and under conditions of incessant and inescapable external organic pressure.

(c) A third part of our educational task has to do with inducing the public to support ecological teaching and research. What is perhaps even more important is the education of the public in appreciation of the need for preservation of the conditions necessary for proper ecological studies. This last-mentioned function, while not of a type ordinarily intrinsic to national scientific societies, is, nevertheless, one of such importance and one involving such a genuine responsibility on the part of some organization that we may well dwell upon it for a few moments at this time.

(3) We are all too deeply impressed with the need for the preservation of natural conditions and the conservation of native plants and animals for it to be necessary before this group to enlarge upon the need. We do not have to prove it, we admit it! Unfortunately, however, the general public neither admits it nor knows anything whatever about it. That natural areas are necessary for research *in situ* and for controls against research conducted elsewhere and against our agricultural and industrial developments has little meaning to the ordinary sojourner in this great land that we appropriated some three hundred years ago from its original guardians and conservators. Now, as a matter of fact, the ordinary present-day sojourner might very well say that we have done so much better for ourselves through despoliation than our predecessors did through intensive, if partly unintentional, conservation, that the argument for conservation seems to him to be very weak. We have, then, not only to overcome the inertia of the human mind reinforced by the ignorance of the technically uninformed but also to contend against a sort of *prima facie* evidence as it were. The answer to the objection is too easy. Obviously civilization, our own, as well as any in the past, is based upon the utilization of available resources, natural and human. We are committed to civilization and, therefore, the only debatable question is whether current modes and degrees of utilization tend in every respect to the realization and perpetuation of the desired form of civilization. Each thoughtful individual, interested in either human or physical materials, will answer the question in any particular instance according to the facts presented to him and in the light of his own ideals and judgment.

Dr. H. C. Hanson has recently called my attention to the fact that about 42 per cent. of the exposed areas of the surface of the earth is grassland. Not only in America but throughout the world mankind has long engaged in completely changing the aspects and conditions of the grassland areas, to say nothing of the forests and streams, and apparently without ever giving the least consideration to the secondary effects of this disturbance. Nowhere in this country, at least, has there ever been expressly set aside a single adequate area of grassland as a control or check plot. This is an extraordinary condition, and it might seem even more so were it not for the fact that we see so many other indications, in respect to war for example, that modern man is still at the beginning and not at or beyond the end of the real Renaissance. Now we are gaining some appreciation of the unhappy results that sometimes flow from our thoughtless policies with respect to grasslands.

It seems to have been the work of a Divine Providence to cover the greater part of the earth with the seas and at the same time to endow mankind with no means of making any great change in them. "I will give you," he might have said, "dominion over the lands, over the beasts of the field and the birds of the air and over the shrubs, trees and grasses, but over

the oceans you shall have no control. I trust you with small things, but the greater part of the surface of my beloved mundane sphere I shall keep under my own lock and key. By means of the seas, which you can not measurably modify, I shall protect you against your own follies." So the undisturbed high seas remain the great balance wheel of the terrestrial machine, the chief source of the rainfall necessary for the continuance of organic life on land, the real fountainhead of the waters whose return journey to the ocean carries the power required for our industries, the mainstay in regulation of temperature, the molder of climates. Concerning the significance of the seas to organic life anywhere, I do not need to say more to climatologists, geologists or biologists. Suppose that man could have put his plow and machinery and his chemical reagents to work on the whole surface of the earth. Might he not long ago have decided that such a great expanse of brine was an error in Creation, as he has in effect concluded, and perhaps properly, with reference to the great areas of forests and grasslands? Might he not have converted the saline waters into some other chemical form? Think how much more tasty or more useful the sea waters might be were they turned into 20 per cent. alcohol, for example, or into gasoline; and we might have had now to form a committee for the preservation of some small marine areas to be kept always as scientific "controls" and as refuges for the native population of non-alcohol addicted and non-gasoline tolerant diatoms, coccolithophores, Salpas, etc.—very useless things in the eye of the practical man, but none the less interesting to the field biologist.

But the designer of nature gave us no opportunity to bring such things to pass. "No," he might have said, "you may ravage the forests and you may drain the marshes, you may change the virgin grasslands into desert, you may pollute the waters and dam the streams as much as you please. You may accomplish much that is good by doing these things wisely; you may effect great harm by doing them unwisely. You mean well, but all the same, and for reasons that are quite satisfactory to myself, I put quite out of your reach the seas as the mainstay of organic life on your planet." And this is not as facetious as it may sound!

Our several committees and important committees of the National Research Council, under the leadership of such men as Shelford, Weese, Hanson, Anthony, Adams and others, are doing much to inform us and to educate the public in respect to the very important matter of conservation.

So much for what I conceive to be the major functions of the Ecological Society; first and foremost, the promotion of basic research in ecology; second, the education of the biological world, in which we ourselves are included, and the education of the younger generation of students for whose proper intellectual development we are vested with some responsibility; and thirdly, the education of American citizens and of the political and administrative leaders of that citizenship in respect to the conservation of our natural biological resources. I put these functions in this order advisedly; because without a science of ecology, the natural areas would be of very little value, and without education there is not the slightest chance of securing the preservation of natural areas or of having them maintained and used to advantage by those who follow us.

Now, let us turn briefly to certain functions which may be called minor functions or corollaries of the major functions, but which are none the less important.

(4) One of these corollary functions we may describe as integration. The society is a specialized one, and it will remain so if it is true to its purposes. Other societies have their special fields of interest—heredity, plant diseases, parasitology, etc.; ours is ecology. Nevertheless, and without prejudice to our special function, this society should be especially interested in cooperation, in the general principle of integration. It is through the Ecological Society that botanists, zoologists and geologists are brought together. It is obvious also that the geographers are concerned in ecology; it might indeed be said that geography is a branch of ecology. It is probably unfortunate that there is not yet as intimate cooperation between physiology and ecology as would be desirable. Some physiological research might be sounder and more effective in approximation to the truth if correlated with field studies, and the ecologist stands always in need of the best physiological training and of the further aid of the specialized physiologist. Doubtless, also, better coordination of the work of geneticists, taxonomists and ecologists is a part of the future. The biochemist and the biophysicist are easily found to be needed in the advancement of ecological science and perhaps to be helped reciprocally by contacts with ecological problems.

The Ecological Society is in itself, to a degree, a coordinating and integrating agency. I have already expressed a strong personal conviction that biologists will be compelled sooner or later, and probably not very much later, to form a closer union, a more compact organization. I hasten to add that I am sure the Ecological Society can not itself afford the basis for that organization; it is an agency for specialized service and must so continue to be. I do feel strongly, however, that this society and others should take a keen and active interest in any sound movement looking to a closer union of biological societies, whether that end may be best accomplished through the existing

Union of American Biological Societies or through the formation, as some have suggested, of a new American Biological Society. I merely throw out the thought for your consideration.

(5) Our presentation of the functions of the society would not be complete if we did not allude to its service in promoting fellowship among the ecologists and all interested in or appreciative of ecological science. I mention the idea of fellowship not to discuss it, but only in order not to seem to exclude or to depreciate what is indeed a matter of vital importance. However impersonal we try to be in our researches, we are after all human beings subject to all the psychological influences that affect people of any other interest. What we do and what we think is in no little measure the product of the impacts of our associations. We gain in spirit, in perspective, in balance of judgment and in efficiency by our social contacts, especially the contacts with those of like interest and ideals with our own.

With some digressions, which, I hope, have not seemed irrelevant, I have tried to emphasize the significance of scientific societies in general, the crying need among biologists for integration of efforts, and the significance and complexity of the special functions of our particular society.

Now, as we come to an end that may have been too greatly delayed, there is one unpleasant practical conclusion that issues in part from what has been said. Annual program meetings, interim meetings, symposia, sectional organizations, quarterly bulletins, general educational activities and committee work for the preservation of ecological areas, all together are not consistent with an accrual to the general treasury of approximately one dollar per member.

If I must now break the personal precedent of a lifetime, by offering a recommendation for an increase of dues, you will doubtless agree that I have found the best way to make an address to end all presidential addresses.

SCIENTIFIC EVENTS

THE FOREST LAND PROBLEM

PRESIDENT ROOSEVELT has requested the Congress to set up a joint committee to study the forest land problem with a view to taking "definite action" at the next session to check the "using up of our forest resources without replacement."

Mr. Roosevelt emphasized especially the situation respecting private forest lands and made the following recommendations:

1. The adequacy and effectiveness of present activities in protecting public and private forest lands from fire, insects and diseases and of cooperative efforts between the Federal Government and the states.

2. Other measures, federal and state, which may be necessary and advisable that timber cropping on privately owned forest lands may be conducted as continuous operations, with the productivity of the lands built up against future requirements.

3. The need for extension of federal, state and community ownership of forest land, and of planned public management of them.

4. The need for such public regulatory controls as will adequately protect private as well as the broad public interests in all forest lands.

5. Methods and possibilities of employment in forestry work on private and public forest land, and possibilities of liquidating such public expenditures as are or may be involved.

The statement continues:

I make this suggestion for immediate study of our forest problem by this Congress in the belief that definite action should be taken by the Congress in 1939. States, communities and private capital can do much to help—but the fact remains that, with some outstanding exceptions, most of the states, communities and private companies have, on the whole, accomplished little to retard or check the continuing process of using up our forest resources without replacement.

This being so, it seems obviously necessary to fall back on the last defensive line—federal leadership and federal action. Millions of Americans are to-day conscious of the threat. Public opinion asks that steps be taken to remove it.

If the preliminary action recommended is taken at this session of the Congress, Mr. Roosevelt said that he planned to address letters to the governors of states in which the amount of state and privately owned forest land is substantial, asking their cooperation with the Congress and with the executive branch of the government in whatever steps appeared necessary. The message directed particular attention to the southeastern and Pacific Northwest sections.

THE LAKE LABORATORY OF THE OHIO STATE UNIVERSITY

DR. THOMAS H. LANGLOIS has been appointed director of the Franz Theodore Stone Laboratory of the Ohio State University situated on Gibraltar Island in Lake Erie at the entrance to Put-in-Bay Harbor. He succeeds Dr. Dwight M. DeLong, who will continue as professor of zoology and entomology.

Dr. Langlois, who has long been associated with the Ohio Division of Conservation, has been assistant director of the Lake Laboratory during the past year. Under the cooperative arrangement between the university and the division, he will continue to serve as

chief of the Bureau of Fish Management and Propagation of the division.

In approving the appointment of Dr. Langlois, the board of trustees of the university "reiterates its commitment to the operation of the Franz Theodore Stone Laboratory as a station for full-time fresh water biological research, emphasizing as a major objective the undertaking of concentrated long term research upon the problem of the depleted fisheries of Lake Erie and the inland waters of Ohio." At the same time it approved a continuation of the summer teaching and research programs on the island, recommending that the teaching program be extended beyond the summer quarter as funds and personnel permit.

In addition the following recommendations are made:

Immediate employment of a full-time fisheries biologist to study the trends of fluctuations in the fish populations of Lake Erie.

Early appointment of a full-time limnologist to study the character of Lake Erie as an environment for fishes.

Organization this summer of a symposium on "Biology of Fishes," to be conducted for the benefit of summer students at the laboratory and also for interested laymen, including representatives of the commercial fisheries industry.

The Ohio Division of Conservation will make available the space and facilities of its fish hatcheries for fisheries research. It is also agreed that the two cooperative agencies "shall encourage the other governmental and commercial agencies of the United States and Canada to station their fisheries research workers at the Stone Laboratory."

Planned for early study in the research program are:

Nature and causes of fluctuations of abundance of commercial and game fish species, and all forage and predaceous fish species.

Fish nets, their utilization and preservation, with attention to the effects of changes of water temperature on size of mesh and catch.

Relative effectiveness of natural and artificial propagation of the commercial and game fish species and the part played by each in maintaining the fisheries.

Methods of managing the commercial and game fish species and their habitat so as to permit the harvest of the maximum annual crops.

Gibraltar Island was presented to the Ohio State University in 1925 by Julius F. Stone, now chairman emeritus of the board of trustees, as a center for research and study on the biology of the lake region.

THE TENTH INTERNATIONAL CONGRESS OF CHEMISTRY

THE tenth International Congress of Chemistry will be held in Rome from May 15 to 25 under the presidency of Professor Nicola Parravano, president of the International Union of Chemistry. Other officers are:

Vice-presidents: Honorable Professor Giuseppe Bruni, director of the Superior Institute of Engineering at Milan; Honorable Engineer Guido Donegani, president of the "Montecatini"; Senator Prince Piero Ginori-Conti, and Honorable Dr. Giovanni Morselli, managing director of Carlo Erba & Co., Ltd.

Secretary: Professor Dr. Domenico Marotta, director of the Institute of Public Health of the Ministry of the Interior.

The Board of Presidency, of which the above are members, is aided by a Scientific Committee, presided over by Professor Francesco Giordani, Italian Royal Academician.

The scientific meetings will be held in the buildings of the "University City" and the congress will carry on its work under the following schedule:

May 14.—Reception to welcome all members of the Congress and their families.

" 15.—Opening meeting.
Tour of the city of Rome and reception at the Palatine.

" 16.—Two general conferences.
One general conference. Papers read dealing with each section.
Concert.

" 17.—Excursion to Ostia. Visit to the ruins and modern sea front. Dinner.
Two general conferences. Papers read dealing with each section.

" 18.—Two general conferences.
One general conference. Papers read dealing with each section.
Reception.

" 19.—Excursion.

" 20.—Two general conferences.
One general conference.
Papers read dealing with each section.

" 21.—Closing of the Congress.
Closing banquet.

There will be eleven sections as follows: Chemistry and scientific thought, Basic chemical products, Chemistry and the utilization of the various forms of energy, Chemistry and alimentation, Chemistry and the house (chemistry and clothing), Chemistry and health (chemistry and hygiene, chemistry and beauty care), Chemistry and documentation (chemistry and advertising, chemistry and recreation), Chemistry and agricultural production, Chemistry and industry, Chemistry and transport, Chemistry and defence. Each section will have a president, a vice-president and a secretary. It is the plan of the congress that the sections shall consider "the relation of chemistry to the various forms of thought and of human activity." During the week general lectures have been arranged. The official lan-

guages of the congress are Italian, English, French and German.

After the close of the congress on May 22, tours of inspection to industrial plants and tours of general interest have been organized. The meetings of the tenth International Congress of Chemistry and the thirteenth Conference of the International Union of Chemistry will be held simultaneously.

THE DALLAS MEETING OF THE AMERICAN CHEMICAL SOCIETY

A SEMI-ANNUAL meeting of the American Chemical Society, under the presidency of Dean Frank C. Whitmore, of the Pennsylvania State College, will be held at Dallas, Texas, from April 18 to 21. An attendance of 1,500 chemists is expected.

The meeting will be open for registration from four to eight P.M. at the Adolphus Hotel on Sunday evening and all day on Monday. A general program has been planned for Monday beginning with a council meeting at 10:00 A.M. In the afternoon Professor Harry B. Weiser, of the Rice Institute, will make an address on "The Constitution of Colloidal Systems of the Hydrous Oxides" and Dr. Per K Frolich, of the Standard Oil Company of New Jersey, will discuss "Recent Chemical Developments in Petroleum Technology." The third speaker will be Dr. D. P. Morgan, of Scudder, Stevens and Clark, investment counsel, New York. Dr. Whitmore will preside, Dr. Henry W. Harper, dean emeritus of the Graduate School of the University of Texas, will be honorary chairman, and Dr. N. C. Hamner, president of the Southwestern Laboratories, Dallas, has been named general chairman. At this session the Eli Lilly and Company Award in Biological Chemistry will be presented to Abraham White and the Women's Award in Chemistry, initiated by Francis P. Garvan, will be presented to Emma Perry Carr.

An extensive program of technical papers will be presented before the various divisions of the society. The divisions meeting at Dallas with their chairmen are: *Agricultural and Food Chemistry,* H. R. Kraybill; *Biological Chemistry,* Walter C. Russell; *Chemical Education,* B. C. Hendricks; *Gas and Food Chemistry,* H. H. Lowry; *The History of Chemistry,* Tenney L. Davis; *Industrial and Engineering Chemistry,* W. L. Badger; *Medicinal Chemistry,* George D. Beal; *Organic Chemistry,* Lyndon F. Small; *Paint and Varnish Chemistry,* E. E. Ware; *Petroleum Chemistry,* J. C. Morrell; *Physical and Inorganic Chemistry,* Harold S. Booth; *Sugar Chemistry and Technology,* Horace S. Isbell; *Water, Sewage and Sanitation Chemistry,* A. P. Black.

Five special symposia have been arranged. New developments in the potash industry in the Southwest will be surveyed in a symposium sponsored by the Divisions of Physical and Inorganic and Industrial and Engineering Chemistry, with Dr. J. W. Turrentine, president of the American Potash Institute, Washington, D. C., as chairman. "Recent Advances in the Nutritional Evaluation of Feeding Stuffs" will be the subject of another symposium under the auspices of the Divisions of Biological and Agricultural and Food Chemistry. Together with the Division of Medicinal Chemistry, these divisions will also hold a symposium on "Vitamins." Sulfur, an important natural resource of Texas, will be treated in a group of papers presented before the Division of Industrial and Engineering Chemistry. The Division of Physical and Inorganic Chemistry plans a symposium on the "Application of Polarized Electrodes in Analytical Chemistry" under the chairmanship of Professor I. M. Kolthoff, of the University of Minnesota. The Division of Chemical Education will devote a session to "Teaching Elementary Organic Chemistry." Other divisions are arranging programs in the fields of cellulose, gas and fuel, microchemistry, paints and varnishes, petroleum, sugar, water, sewage and sanitation, organic chemistry and the history of chemistry.

THE ANNUAL MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE preliminary announcement of the twenty-second Annual Meeting of the Pacific Division of the American Association for the Advancement of Science is now in press and will soon be distributed to members of the division. The announcement reports the participation of nineteen affiliated and associated societies.

Among the general features of interest will be a symposium on "Climate and Man," in which papers will be presented on: "The Present Climate of California," by Professor John Leighly, University of California, Berkeley, California; "Climate and Agriculture," by Dr. Merrill K. Bennett, Stanford University, California; "Climate and Disease," by Dr. Edward L. Munson, University of California Medical School, San Francisco, California, and "Climate and Science," by Dr. Ernst Antevs, Globe, Arizona. Evening addresses will be presented before the division at large on "Modern Conceptions of the Stellar System," by Dr. J. S. Plaskett, Dominion Astrophysical Observatory, Victoria, B. C., president of the Pacific Division, and on "Animal Experimentation," by B. O. Raulston, professor of medicine, University of Southern California, Los Angeles; A. J. Carlson, professor of physiology, University of Chicago, and Harry B. Torrey, professor of biology, Stanford University. Reviews of recent advances in scientific research will be presented by J. A. Anderson, Mount Wilson Ob-

servatory, on "Recent Instrumental Developments in Astronomy"; H. U. Sverdrup, Scripps Institution of Oceanography, on "Recent Advances in our Knowledge of the Oceans"; C. H. Danforth, Stanford University, on "The Sex Hormones," and R. Goldschmidt, University of California, on "Genetics." Numerous symposia organized by participating societies in the fields of biology, chemistry and physics have also been arranged.

Members proposing to present papers before any of the societies are reminded that titles and abstracts of such communications must be in the hands of the secretary of the society before which the paper is to be given by April 27.

SCIENTIFIC NOTES AND NEWS

DR. DONALD D. VAN SLYKE, member of the Rockefeller Institute for Medical Research, New York, was awarded on March 10 the degree of doctor of medicine, *honoris causa,* by the University of Oslo, Norway.

DR. ALEXANDER WETMORE, assistant secretary of the Smithsonian Institution, has been elected an honorary member of the British Ornithologists' Union.

DR. G. H. PARKER, professor of zoology, emeritus, of Harvard University, has been elected an honorary member of the Buffalo Society of Natural History.

PROFESSOR A. KROGH, of Copenhagen, and Professor L. Lapicque, of Paris, were elected on March 12 to honorary membership in the Physiological Society, London.

THE award of the American Association of Teachers of Physics, made at the January meeting of the society, for "notable contributions to the teaching of physics," was presented on March 31 to Dr. Edwin H. Hall, professor emeritus of physics at Harvard University.

THE Agricultural Club of the College of Agriculture of the University of Missouri presented Dean F. B. Mumford with a plaque at its annual banquet in appreciation of his work with students and their organizations during his twenty-nine years as head of the college. Dean Mumford, who retires this summer, was the principal speaker at the banquet.

THE bronze medal for 1938 of the John Burroughs Association was presented to Dr. Robert Cushman Murphy in recognition of his book on "The Oceanic Birds of South America" at the annual memorial birthday celebration held by the association in the American Museum of Natural History on the evening of April 2. Dr. Clyde Fisher presided over the ceremonies and presented the medal to Dr. Murphy.

THE Royal Geographical Society has announced the award of the Royal Medals as follows: The Founder's Medal to John Rymill, for his organization and leadership of the British Graham Land Expedition, 1934–37, and the Patron's Medal to Eric Shipton, for his explorations around Nanda Devi and Mount Everest and his conduct of the Shaksgam Expedition of 1937. The Victoria Medal has been awarded by the council to A. R. Hinks, for his contributions to the study of geodesy and the figure of the earth, map projections and photogrammetric survey; The Murchison Grant to Martin Lindsay, for his journey across Greenland in 1934; The Back Grant to Thomas Hay, for his contributions to the physical geography of the Lake District; The Cuthbert Peek Grant to Bradford Washburn, for his explorations and glacier studies in Alaska, and the Gill Memorial to Ivan Champion, for his explorations and surveys in Papua.

Nature states that the following awards of medals of the British Institute of Patentees have recently been made: Grey-Wilson Memorial Gold Medal to Dr. S. C. Blacktin, for a dust and smoke meter; Yorkshire Gold Medal to W. H. Siddle, for a wire-joining tool; Special Silver Medals to Mrs. F. Peace for a superhet washer, J. R. Churchill for a chair, W. McClelland for a balanced two-stroke engine, and to F. W. Mason for an automatic blind control.

DR. E. V. MCCOLLUM, professor of biochemistry at the Johns Hopkins University, was elected president of the American Institute of Nutrition at its fifth annual banquet on March 30. He succeeds Dr. Mary Swartz Rose, of Teachers College, Columbia University. Other officers elected were: Dr. T. M. Carpenter, of the Carnegie Institution, Boston, *vice-president;* Dr. L. A. Maynard, of Cornell University, *secretary;* Dr. G. R. Cowgill, *treasurer,* and Dr. Helen S. Mitchell, of the Massachusetts State College, *member of the council.*

DR. GLENN E. CULLEN, of the University of Cincinnati, will be chairman of the Federation of American Societies for Experimental Biology during the coming year by virtue of his election at the recent meeting in Baltimore as president of the American Society of Biological Chemists. He succeeds Dr. Walter E. Garrey, of Vanderbilt University. Dr. Garrey was reelected president of the American Physiological Society; Dr. Arthur L. Tatum, of the University of Wisconsin, was elected president of the American Society for Pharmacology and Experimental Therapeutics, and Dr. C. Phillip Miller, University of Chicago, was elected president of the American Society for Experimental Pathology. Secretaries of the societies were

elected as follows: Dr. Andrew C. Ivy, of Chicago, the American Physiological Society; Dr. C. G. King, Pittsburgh, the American Society of Biological Chemists; Dr. Philip Grabfield, Boston, the American Society of Pharmacology and Experimental Therapeutics, and Dr. Paul R. Cannon, of the University of Chicago, the American Society for Experimental Pathology. Next year's convention will be held in March in Toronto.

JAMES E. RICE, professor emeritus of poultry husbandry at Cornell University, will be general chairman of the seventh World's Poultry Congress and Exposition, to be held in Cleveland, Ohio, from July 28 to August 7. This congress has as its principal purpose "a stimulation of interest in world poultry affairs and a promotion of friendly international relations by bringing together those interested in various phases of the industry from all parts of the world."

DR. FREDERIC S. LEE, research professor of physiology, and Dr. Wendell T. Bush, professor of philosophy, will retire from the faculty of Columbia University on June 30.

WILLARD P. GERRISH, assistant professor of mechanical engineering since 1892 on the staff of the Harvard College Observatory, will retire at the end of the academic year with the title emeritus.

PROFESSOR CHARLES H. SMILEY has been made chairman of the newly established department of astronomy at Brown University and director of the Ladd Observatory. The department will offer courses in descriptive and practical astronomy and selected topics in the field. Instruction will include demonstrations and the use of astronomical equipment at the observatory, work which has been conducted by the department of mathematics since 1914.

DR. WILLIAM DUNCAN STRONG, associate professor of anthropology at Columbia University, formerly anthropologist in the Bureau of American Ethnology of the Smithsonian Institution, has been appointed director of the newly established archeological laboratory at Columbia University. It is planned to initiate an extensive program of research, which will include archeological expeditions by graduate students to North Dakota and to Central and South America.

DR. JOSEPH SLEPIAN, consulting research engineer of the Westinghouse Electric and Manufacturing Company, has been appointed associate director of the laboratories of the company at East Pittsburgh.

THE council of the University of Liverpool has appointed Dr. Rupert Montgomery Gordon, director of the Sir Alfred Lewis Jones Research Laboratory, Freetown, Sierra Leone, to the Dutton Memorial Chair of Entomology, in succession to Emeritus Professor W. S. Patton, who retired in December.

DR. BURGESS BARNETT, who was curator of reptiles under the Zoological Society of London from 1930 to 1937, has been appointed superintendent of the Rangoon Zoological Gardens. He will take up his new work in June. Dr. Barnett intends to continue his research work on snake venom and its applications to medical practice.

A UNITED PRESS dispatch dated March 28 states that among those taken into so-called "protective custody" by the Nazis in Austria are Dr. Otto Loewi, professor of physiology at the University of Graz, Nobel laureate, and Ernst Straeussler, professor of criminal psychology. Dr. Erwin Schrödinger, professor of theoretical physics at the University of Vienna, has been dismissed.

DR. KNUT LUNDMARK, professor of astronomy at the University of Lund, Sweden, gave an evening lecture before the Franklin Institute, Philadelphia, on March 24. He spoke on "Exploding Stars."

DR. RAYMOND PEARL, professor of biology at the School of Hygiene and Public Health of the Johns Hopkins University, on April 15 will deliver a public lecture on "Long Life and Living," under the auspices of the Institute of Medicine of Chicago.

PROFESSOR W. H. TWENHOFEL, of the University of Wisconsin, addressed the Geological Society of Tulsa, Oklahoma, on the evening of March 11, and the Geological Society of Oklahoma City on the following evening. His subject was "The Rate and Continuity of Deposition of Sediments."

DR. CHARLES E. FRILEY, president of the Iowa State College, will deliver the main evening address at the meeting of the Iowa Academy of Science at Sioux City on April 15. He will speak on "Science and Society."

DR. GUSTAV EGLOFF, director of research of the Universal Oil Products Company, has been appointed a delegate of the National Research Council and the National Academy of Sciences to the tenth International Congress of Chemistry and the thirteenth conference of the International Union of Chemistry in Rome, to be held from May 15 to 21. He will address the congress on "Petroleum—Its Chemical and Industrial Significance." He has also been appointed chairman of a meeting on the cracking of shale oils during the Conference on Shale and Cannel Coal to be held in Glasgow from June 6 to 11.

DR. WILLIAM BOYD, professor of pathology in the School of Medicine of the University of Toronto, will deliver the 1938 Porter lectures of the School of Medicine of the University of Kansas. On April 19 he will speak at Kansas City on "Bronchial Carcinoma" and on April 20 at Lawrence on "Growth, Normal and Abnormal"; on April 20 he will speak on "Nephritis"

at Kansas City. The Porter lectureships are provided through a gift from the late Dr. J. L. Porter, of Paola, to be used for the promotion of scholarship and research. The fund provides for a scholarship, and the balance of the income is devoted to the lectures.

THE last lectures in the De Lamar series at the School of Hygiene and Public Health of the Johns Hopkins University will be given on April 12, "The Immunology of Epidemic Influenza" by Dr. Thomas Francis, Jr., member of the staff of the International Health Division of the Rockefeller Foundation; on April 19, "Cellular Changes in Leprosy," by Dr. E. V. Cowdry, professor of cytology at Washington University; and at a date to be announced, "Sinanthropus pekinensis and Its Significance for the Problem of Human Evolution," by Dr. Franz Weidenreich, honorary director of the Cenozoic Research Laboratory of the National Geological Survey of China.

THE seventh International Botanical Congress will be held at Stockholm from July 17 to 25, 1940. The secretary of the congress, Rudorf Florin, writes: "As it is highly desirable that the Stockholm Congress should be truly international, your cooperation in deciding the places and dates of other botanical conferences and meetings, with a view to avoid any clashing, would be much appreciated. It would be of great advantage if the time between July 17 and September 1, 1940, could be kept free from other conferences, in order to enable botanists to attend the International Congress and participate in its excursions."

AN appropriation of $220,000 has been approved by the regents of the University of California for the construction of the first of a group of life science buildings at Los Angeles. The money was made available through the sale of the Vermont Avenue campus to the Los Angeles Junior College. The first building in the new group will be an office and classroom structure. Other units will include a laboratory building and an animal house, for which no provision has as yet been made.

DISCUSSION

THE DENSEST POSITION OF HOMOLOGOUS BODIES

THE article on "The Shape of Compressed Spheres,"[1] by Professor Frederic T. Lewis, is of much interest. In the first place it seems to show that the physical laws in the microscopic world are identical with those of the world in which we live. There seems to be an economic striving in many of the phenomena of nature which are explained by means of the mathematical theory of maxima and minima. In the second place, it is pleasing to see that the most abstruse theories in pure mathematics have immediate practical applications in such subjects as anatomy, botany and biology. The intelligent layman can understand these subjects, even if he finds little interest in mathematics.

Professor Lewis writes: "After years of patient reconstruction, cells were found to be 14-hedral, so that bubbles, liquid drops, and semi-fluid bodies in aggregates which fill space could all be said to be of that one form. Yet there remained the anomalous conclusion that compressed solids are dodecahedral."

If the anatomists will allow us, we shall assume that there is a law of nature according to which the cells in space strive to take such positions that the gaps between them occupy as little space as possible. In other words, the cells strive to occupy as much space as possible, leaving the minimum amount of space unoccupied. It is then seen that the results of Professor Lewis's observations are interesting checks on the mathematical theory. To give a detailed account of this theory would require here more space than we have at our command. I may outline the method of procedure, however, and cite the mathematical results that have been found.

[1] SCIENCE, 86: 2244, December 31, 1937.

The general problem may be headed as follows: *Analytic formulation of the condition for the densest lattice-formed position of congruent homologous bodies in space.* I shall in the sequel make references to two works by the great mathematician, Hermann Minkowski, the one *Diophantische Approximationen* (= D.A.), the other *Gesammelte Abhandlungen* (= G.A.). The problem (D.A., p. 83) is: ***A convex body K with center at the origin 0 is given. The body is supposed to be symmetric with regard to the origin. Determine a lattice in x, y, z with 0 as origin which besides 0 has no other lattice point in the interior of K, and at the same time offers a fundamental paralellopiped of least volume.***

For the body K we take here a sphere. It may be shown that by expressing x, y, z as linear forms in ξ, η, ζ with integral coefficients and determinant $= \pm 1$ and then using the substitutions

$$\xi = \lambda X + \lambda' Y + \lambda'' Z,$$
$$\eta = \mu X + \mu' Y + \mu'' Z,$$
$$\zeta = \nu X + \nu' Y + \nu'' Z,$$

we may so choose, x, y, z that six lattice points in X, Y, Z appear on the surface of the sphere, the problem being to determine the nine elements of the deter-

$$\Delta = \begin{vmatrix} \lambda, & \lambda', & \lambda'' \\ \mu, & \mu', & \mu'' \\ \nu, & \nu', & \nu'' \end{vmatrix},$$

minant, such that Δ be a minimum. The six lattice points in X, Y, Z determine a lattice octahedron, its six vertices being on the surface of the sphere while there are no other lattice points on its interior. The sphere being symmetric with respect to 0, each point on the surface of the sphere has a diametrically opposite point on the sphere. We may accordingly take the six lattice points as A, A_o; B, B_o; C, C_o where A_o is the opposite point of A, etc. Now to minimize the determinant above, we may minimize the tetrahedron OABC, and this leads to a cubo-octahedron (the part of an octahedron contained in a cube). The figure was drawn by a former student of mine, Dr. Paul Pepper. It is seen that the figure has 12 vertices and 14 sides (facets). It may be shown (D.A., p. 112; G.A., II, p. 21) that at the 12 vertices the given sphere presses against 12 other spheres, while (G.A., II, p. 49) each octahedron presses against 14 sides of the cubo-octahedron. It may be of interest to the anatomists to know that were space filled in the manner indicated by spheres and octahedra the volume of space occupied by the gaps between the spheres to the volume of all space is as $\pi/6 : 1/\sqrt{2}$, while that between the octahedra and all space is as 1 : 19.

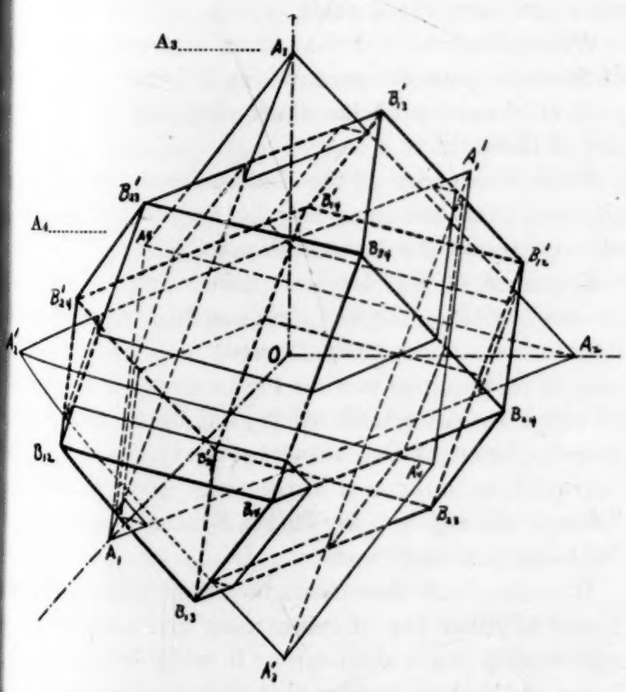

FIG. 1. The points A_1, A_2, A_3, A_4 are the vertices of a tetrahedron T; A'_1 A'_2, A'_3, A'_4 are those of T′, where T′ is the reflection (image) of T through O. B_{ij} (i, j = 1, 2, 3, 4) is the mid-point of the segment $A_i A'_j$, while B'_{ij} is the mid-point of $A'_i A_j$. It is seen that $B_{ij} = B'_{ji}$. The points B_{ij} constitute the set of vertices of a 14-faced convex polyhedron. Minkowski called this polyhedron a "cubo-octahedron" inasmuch as it is the portion of an octahedron contained in a cube. (See also statement at end of article.)

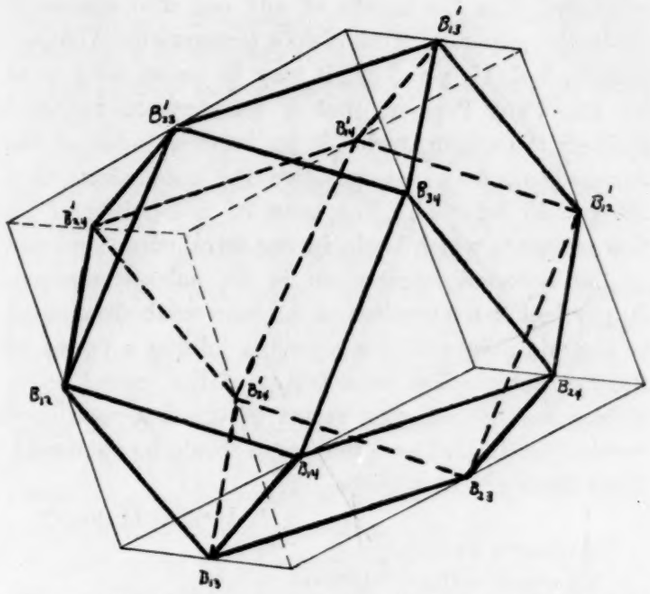

FIG. 2. The figure in heavy lines is the cubo-octahedron.

Sir D'Arcy Thompson's belief that "plastic spheres will yield dodecahedra on compression" seems well founded. The body K under compression is no longer a sphere. We shall assume that it is everywhere a convex body and symmetric with regard to 0. Observe that if the point P = (X, Y, Z) is on the boundary of K, then the *opposed* point $P_o = (-X, -Y, -Z)$ is also on K. Then to be able to find the minimum (or the different existing minima) of Δ it is sufficient that the lattice in x, y, z be so chosen that in X, Y, Z:

(I) the lattice points
X, Y, Z) = 1,0,0; 0,1,0; 0,0,1; 0,1,0; 1,0,1; 1,1,0 lie on the boundary of K;
(II) the points 1,0,0; 0,1,0; 0,0,1; 0,1,1,; 1,0,1; 1,1,0 lie on the boundary of K while (1,1,1) is outside the boundary;
(III) when (1,1,1) is also on the boundary as are also the other six points just mentioned.

We are assuming in all cases that no lattice point save 0 is on the interior of K. This being the case, no convex body can have a volume greater than 2^3 (= 8). Minkowski shows (G.A., Vol. II, p. 39 and p. 20) that the six lattice points and their opposed six points in (I) form the twelve vertices of the cubo-octahedron given above, while in (III) the seven lattice points and their opposites give the vertices of a rhombic dodecahedron.

In the case (II) it is seen that bodies formed by 12 planes (such bodies being nowhere concave) (G.A., II, p. 42) constitute a system of bodies in densest lattice formed placement. This case (II) seems in contradiction to Lord Kelvin's assumption. (Baltimore Lecture (1904), pp. 618 ff.) This case seemingly is a boundary case, and I judge possibly it is outside the domain of

cytology. For the benefit of any one who wishes to study the paper in Minkowski's Gesammelte Abhandlungen, Vol. II, pp. 3 ff., it may be noted, as proved by Dr. Paul Pepper, that a tetrahedron, reflected through the origin, which is an interior point of the tetrahedron, does not produce the octahedron that Minkowski believed. The locus of mid-points of all line segments which begin in one tetrahedron and end in the reflected tetrahedron is the cubo-octahedron. In particular, the vertices of the cubo-octahedron occur as the mid-points of line segments joining a vertex of the first tetrahedron to a vertex of the second tetrahedron not the reflected vertex of the first-mentioned vertex (for in that case the origin would be obtained). Thus there are 12 vertices.

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THE DISCOVERY OF THE FEMUR OF SINANTHROPUS PEKINENSIS

AMONG the extensive material recovered from Locality 1 at Choukoutein during the excavations of 1936–37 and subsequently prepared in the laboratory, Dr. W. C. Pei discovered two fragments of femora. The general appearance of these specimens led Pei to believe that they were of human origin and probably belonged to *Sinanthropus*. A careful study and comparison with human and anthropoid thigh-bones resulted in the conclusion that the femora undoubtedly belong to *Sinanthropus*.

One of these fragments, femur J, represents a portion of the middle of the shaft and measures 58 mm. The bone is completely fossilized and burnt, as is evident by the marked blackening of the entire anterior and medial surface and on the part where it was broken off. That we are actually dealing with a human femur is demonstrated by the form and size, but particularly by the existence of a rather distinct pilaster (Broca) which occupied the middle of the posterior surface and bears a well-developed linea aspera dividing into characteristic medial and lateral lips toward the end of the fragment.

The other fragment, femur M, embraces almost the entire diaphysis. Its length is 312 mm. This femur is also strongly fossilized. Like femur J this piece also shows a distinct pilaster running along the middle of the posterior surface and bears a linea aspera consisting of two lips. Estimated on the basis of the length of the preserved portion of the femur, the total length may have been 400 mm.

The femur of *Sinanthropus* has, in common with that of recent man, the general shape and the formation of a pilaster with a two-lipped linea aspera. In addition, there is a distinct suprapatellar fossa. On the other hand, the femur differs from that of recent man by its stoutness and the following specific features: (1) a very pronounced platymery of the entire length of the femur combined with the formation of a distinct pilaster; (2) a very faint curvature, the greatest height of which is located near the lower end of the diaphysis; (3) the transversal diameter of the shaft is narrowest near the lower end and gradually increases toward the upper portion; (4) there is a distinct but only faintly developed crista lateralis superior; (5) sections show that the cavity is narrow with rather thick walls, especially the anterior and posterior ones.

Femora of the Neanderthal group differ from the femur of *Sinanthropus* by their greater stoutness, the transversal diameter being narrowest in the middle of the shaft, by a much more pronounced curvature the greatest height of which is also located near the middle of the shaft, and finally by the development of a very strong crista lateral is superior. To what extent these differences are due to sexual characters is difficult to define. It seems that all the femora available of the Neanderthal group belong to male individuals, whereas I consider the two femora of *Sinanthropus* as belonging to females on account of the smallness of the two main diameters of the shaft.

When compared with the femora of great apes, those of *Sinanthropus* represent quite a different type. The general character of the shaft does not conform to any of them.

These discoveries of the *Sinanthropus* femora may also serve to shed some new light upon the problem connected with the *Pithecanthropus* femur.

Femur M of *Sinanthropus* differs from the *Pithecanthropus* femur by exactly those features by which it differs also from that of recent man. With reference to its popliteal surface the pronounced convexity of which Dubois considered typical for *Pithecanthropus,* the femur of *Sinanthropus* merely shows a slight convexity, as is common in recent man, the platymeric index of this region being 76.4 in *Sinanthropus* against 100.0 in *Pithecanthropus.*

It results from these facts that the *Pithecanthropus* femur is either one of recent man and with no close relationship to the skull-cap or it really belongs to the latter and thereby testifies that *Pithecanthropus* represents a much more advanced hominid type than *Sinanthropus.* I consider the first alternative to be the correct one.

My recently stated conclusion that *Sinanthropus* must have already adopted a completely upright posture has now been confirmed by the discovery of the femur. Since the total length of the femur (female) may have been about 400 mm, the stature of the woman can be estimated to have been circa 5 feet

(152 cm), a height which would correspond to 5 feet 4½ inches for male individuals. With such a height *Sinanthropus* ranges within the group composed of medium-size people of to-day. At any rate, it is certain that *Sinanthropus* was not a pygmy.

The three facts, namely, that the two femora were found as isolated pieces without any other human bones, furthermore that they represent only more or less complete specimens and finally that the fragment of femur J was burnt, point in the same direction as the finds of skull and jaws. All the *Sinanthropus* bones recovered from Locality 1 of Choukoutien had received the same treatment as the game which *Sinanthropus* hunted. This hominid, therefore, was a cannibal.

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Peiping, China

INDUSTRIAL RESEARCH LABORATORIES

The increase in the number of research laboratories maintained by industrial concerns in the United States during the last few years has made it seem desirable to issue a new edition of the National Research Council's Bulletin, "Industrial Research Laboratories of the United States," fifth edition.

On March 25 questionnaires were mailed to the 1,562 concerns which were included in the last edition of 1933, and to a large number of new concerns which are thought to maintain laboratories.

If the reader of this note is a member of a firm which maintains a laboratory where research looking towards the development and improvement of products is carried on, it is hoped that he will ascertain whether a questionnaire has been received by his company, and if not that he will request one from the Library, National Research Council, 2101 Constitution Avenue, Washington, D. C.

There is no charge for the entry in the bulletin, the only requirement being that the laboratory is undertaking research.

It is desirable to have the information for the bulletin in hand as soon as possible so that the publication may appear within the current year.

Callie Hull,
Librarian

THE CYCLOPEDIC VALUE OF BIOLOGICAL ABSTRACTS

The value to the research worker of an up-to-date synthesizing abstract service covering the world's progress in the broad field of biology has been stressed from many view-points and by many individuals. This was the primary aim in launching *Biological Abstracts*. What has not been sufficiently emphasized is the fact that outside his own field the specialist immediately becomes a layman, who, if he is an intelligent layman, is constantly seeking information on a wide range of subjects cropping up in his daily life at every turn and about which he knows little or nothing.

Even without an adequate abstracting service, I in my own field of phytopathology am not irrevocably lost, because I have at least some idea as to where I must look to find out what I want to know. The task may be exceedingly laborious, but it at least is not entirely insurmountable. However, the further I go from my own field the more I am reminded of the babes lost in the woods. The information in textbooks is often ten years old before it is out, the indexes are rarely if ever adequate, and unless I am fortunate enough to have a large library at my elbow even such sources are not available to me.

I am reading an interesting article on *Arbacia*. My early zoological training not having sunk entirely beyond recall, I remember it to be an animal of some kind, but where does it belong? I reach for my *Biological Abstracts* index. Under *Arbacia* I am referred to the taxonomic index, and, presto, I know that it is an echinoderm, and if I wish to go further the detailed analytical index refers me to specific and diverse information on many species of the group. Examples might be multiplied indefinitely: I am in doubt about the spelling of an insect name. Knowing the infinite care with which Dr. Mary Jones Fisher has checked over the spelling of zoological names in *Biological Abstracts* I am as confident as though I had gone to the original source. I want to learn quickly some specific point about diet, this or that vitamin, the effects of sodium chloride on the system, what does the electrocardiagram mean in terms of life processes or expectancy, what human diseases are spread by insects, what are the effects of light on plants and animals, etc., etc. The taxonomic, geographical, geological and fully cross-referenced, detailed analytical subject indexes of *Biological Abstracts* lead me quickly to most of what I want to locate in the daily routine of work and general reading.

I am not suggesting here the potential usability of *Biological Abstracts* as it might sometime become, but rather am presenting my own actual personal experience with it as it was yesterday and is to-day. I shall continue to use it in such a capacity for years to come, even though no further issue should ever appear.

What does all this boil down to, but that the value of *Biological Abstracts* can scarcely be overestimated, even when viewed solely as an up-to-date encyclopedia of information on all matters pertaining to living things, for the daily use of intelligent, inquiring minds, old and young. The educational value in high schools, colleges, industries and homes of such an encyclopedia

of biology brought up to date year by year and provided with the thoroughly adequate types of indexes so carefully worked out by Dr. J. R. Schramm is a matter which can not be lightly turned aside.

For the sake not only of its value to science, but also of its educational and reference value to students and intelligent citizens generally, it is to be hoped that the future of *Biological Abstracts* may be assured.

FREDERICK V. RAND

WASHINGTON, D. C.

SOCIETIES AND MEETINGS

A SYMPOSIUM ON THE ALGEBRA OF GEOMETRY AND RELATED SUBJECTS

A SYMPOSIUM on the algebra of geometry and related subjects was held at the University of Notre Dame on February 11 and 12. Algebra of geometry, not to be confused with algebraic geometry in the classical sense, is a foundation of geometry starting with one class of elements (points, lines, planes, etc.) and two undefined operations called joining and intersecting of elements. It is based on a few simple formulas about these operations, similar to and partly identical with the formulas about addition and multiplication on which the ordinary abstract algebra is founded. That is why mathematicians in Vienna called the calculus which they developed from these assumptions algebra of geometry. In an algebraic way, one can define when an element is part of another element, and then make precise the famous initial words of Euclid "point is that which has no parts." Lines, planes and n-dimensional elements can be defined and the ordinary axioms of geometry be deduced.

In the first of the four meetings, Dr. Marshall H. Stone, of Harvard University, presented a paper on the applications of Boolean algebra to topology. Boole's algebra of logic can be obtained as a special case of the more general algebra of geometry. Mr. Garrett Birkhoff, of Harvard, who, in this country, discovered and developed the algebra of geometry under the name of theory of lattices, presented new applications of his theory to partly ordered function spaces. Dr. E. W. Chittenden, of the University of Iowa, conducted the discussion.

The second meeting, under the direction of Dr. R. T. Hildebrandt, of the University of Michigan, dealt with applications to the theory of groups. Dr. O. Ore, of Yale University, spoke about what he calls structures of groups, *i.e.*, systems of subgroups of a group, which may be joined and intersected like points, lines and planes in geometry. Dr. Saunders MacLane, of the University of Chicago, presented an application of lattice theory to the structure of fields of numbers. Dr. James K. Senior, of the University of Chicago, mentioned some unsolved problems concerning structures of groups, whose solution would be of importance to organic chemistry.

The following morning, Dr. John von Neumann, of the Institute for Advanced Study, Princeton, presented his continuous geometry, in which there are no points and the dimension of the different objects assumes all values between zero and one. Dr. Karl Menger, of the University of Notre Dame, spoke about the algebra of affine geometry developed by F. Alt and himself. Pointing out the desirability of similar algebraic foundations for non-Euclidean and other geometries. The discussion was directed by Dr. I. A. Barnett of the University of Cincinnati.

The last meeting, conducted by Rev. H. Kenna, C.S.C., of the University of Notre Dame, dealt with algebraic questions. Dr. A. A. Albert, of the University of Chicago, spoke about applications of division algebras to geometry. Canon Lemaître, of Notre Dame and Louvain, presented a paper applying hyper-complex numbers to Eddington's interpretation of the equation of Dirac. Dr. Emil Artin, of Notre Dame, gave new proofs of algebraic theorems containing as a special case the theorem of Wedderburn which, applied to geometry, shows that in a space consisting of a finite number of points the law of Pascal is a consequence of the law of Desargues.

On the first evening, Dr. Edward V. Huntington, of Harvard University, gave a general lecture on the method of postulates, entitled "The Duplicity of Logic."

The meeting was attended by a group of more than fifty visitors from various parts of the country.

KARL MENGER

UNIVERSITY OF NOTRE DAME

REPORTS

INDUSTRIAL RESEARCH INSTITUTE

FOR sometime now the research executives of middle-sized industrial corporations, well known for their advanced position in research in their respective fields of industry, have felt the need of an organization in which they could discuss common problems principally concerned with organization and administration of research laboratories.

To determine on the factual basis of a survey and questionnaire to what extent the need for such an organization was realized by directors of research, the Division of Engineering and Industrial Research of the National Research Council sent out 500 letters to an arbitrary selection of industrial research laboratories listed in NRC Bulletin No. 91, representative of many fields of industry and all major industrial areas of the country. Over 400 letters have been received in the survey to date and of six suggested services, one on an information bureau on problems of administration, organization and operation of research laboratories was voted as most important by the majority of those making reply. The most pressing problems in the front of the minds of research executives in industry to-day, irrespective of field of industry or geographic location in the country, are the selection, training, handling, incentive and bonus plans for research personnel. In informal discussions another facet of the perplexing problem of securing adequately trained industrial research workers, several directors of research suggested that specifications based on actual experience be drawn up by a committee of industrial research directors and placed before the Society for the Promotion of Engineering Education and key technical colleges and universities. The problem of hardly secondary importance relates to all phases of organization, administration and operation including such questions as the construction and control of budgets, relation of research laboratory to other departments of an industrial company, the coordination of research activities with market studies and sales promotion, and quantitative measurements for evaluating the value of research both in short term and long term periods.

One significant and primary fact stands out above all in the development of plans for the Industrial Research Institute as they developed thus far. A Steering Committee appointed by Chairman Vannevar Bush and consisting of: Robert B. Colgate, Colgate-Palmolive-Peet Company; H. W. Graham, Jones and Laughlin Steel Corporation; Donald Bradner, Champion Paper and Fibre Company; H. Earl Hoover (D. G. Smellie alternate), The Hoover Company; G. E. Hopkins, Bigelow-Sanford Carpet Company; Oliver Kamm, Parke, Davis and Company; O. A. Pickett, Hercules Powder Company; John M. Wells, American Optical Company; Maurice Holland, Division of Engineering and Industrial Research, National Research Council; met for preliminary discussions of the need for the Institute and the type of services which it could render. Two weeks later the first general organization meeting was held in the board room of the American Society of Civil Engineers, Engineering Societies Building, New York, at which representatives of more than 40 definitely interested corporations participated, indicated and confirmed the findings of the Steering Committee that there were common problems, that they were primarily concerned with improving the general efficiency of research laboratory operation and increasing the return on the research dollar investment. The research executives participating at this meeting agreed that the tangible and direct benefits of the institute in the order of their importance as the plans had developed to date indicated that personal contacts, the opportunity for frequent and informal discussion of common problems was of first importance. Round table conferences on specific subjects participated in by small groups and supplemented by field studies and laboratory visits was a second important service. Third, the external relations of industrial research laboratories, particularly with universities, with other industrial laboratories, with research agencies in the field of pure science might well call upon the pooled experience of all the members of the institute and the evaluation of the operations of a single laboratory against those in the cooperative group.

The institute is primarily designed to serve the middle and small sized industrial research laboratories. Of the 1,600 laboratories listed in Bulletin No. 91, 1,100 have 10 or less personnel, over 700 have less than 5. This is the industrial backbone of research in American industry. This is the representative cross section which the institute hopes to serve. The institute will concern itself primarily with problems of method in research itself, not problems in electronics, chemistry or biology; not problems in soap-making, steel-making or textile weaving; not problems in materials testing or process development. These are the general problems in the efficient conduct of research for whatever purpose and in whatever field. The discussions of interested prospective members of the institute thus far have clearly demonstrated that they are effectively and adequately served in the technical and scientific aspects of their activities by existing agencies. A report prepared by the Engineering Societies Library, however, indicates that the objectives and specific services as outlined in the institute *program for the research laboratory as an institution* is not duplicated by any existing organization.

The institute will not duplicate the services of any existing organization. On the contrary wherever and whenever it appears that any proposed task can be better done by or through another organization, it will turn over that job to the hands best fitted to perform it. The institute as now envisioned will not follow the

conventional pattern of association or society organization and functions, it will attempt to provide "fluid mechanisms"—stripped of all formalism or meaningless detail—for the most effective interchange of information and cooperation in current and vital services at the least possible cost in time, effort and expense.

At an executive committee meeting held in the Engineering Societies Building on March 25, Robert B. Colgate, vice-president of Colgate-Palmolive-Peet Company was elected chairman of the executive committee and Mr. H. W. Graham, general metallurgist, Jones and Laughlin Steel Corporation vice-chairman. The executive committee will serve as a committee of the National Research Council by appointment of Chairman Bush during the formative and development period of the institute. Later it is expected that the institute will be incorporated as a membership non-profit organization under the laws of the State of New York. In the meantime the Division of Engineering and Industrial Research of the National Research Council has offered its facilities, the services of its staff, and its technical resources and contacts during the experimental period. Maurice Holland, director of the division will serve as executive officer of the institute.

MAURICE HOLLAND,
Director, Division of Engineering and Industrial Research, National Research Council
NEW YORK,
MARCH 29, 1938

SPECIAL ARTICLES

SUBLETHAL EFFECTS OF LONG WAVE-LENGTH ULTRA-VIOLET

IN work previously reported on the effect of long wave-length (3,130 and 3,660 Å) ultra-violet radiations upon protozoans[1] large dosages were found to have no immediate visible effects and the animals so irradiated divided when fed and conjugated when starved following generous feeding. In some cases, however, division seemed retarded and the possibility of slight sublethal effects was suggested, but control of the test material was inadequate for accurate work. Subsequent studies of the effects of short wave-length ultra-violet rays upon cleavage of the eggs of the sea urchin (*Strongylocentrotus purpuratus*) and upon excystment of *Colpoda duodenaria* cysts indicated that these were more sensitive and reliable test materials. The effect of long wave-length ultra-violet radiations upon cleavage and excystment of these forms was therefore studied.

The apparatus was similar to that previously employed.[1] The methods for handling Colpoda cysts were similar to those described by Taylor, Brown and Strickland,[2] by whom the materials used here were generously supplied. The excystment studies reported here were made at $20 \pm 0.3°$ C. The methods for handling sea urchin eggs will be described in detail elsewhere. The temperature of the room in which the work on the sea urchin eggs was carried out was $15 \pm 1°$ C.

In a representative set of experiments after a dosage of 400 ergs/mm² at λ3,025Å, which is at the long wave-length end of the lethal spectrum, the 8-celled stage in cleavage of the sea urchin egg was reached about one hour later than in control cultures. While such small doses with λ3,130Å usually had no noticeable effect upon the cleavage rate, a dosage of 3,200 ergs/mm² caused approximately an hour delay in the appearance of the 8-celled stage. With a dosage of 12,600 ergs/mm² the retardation was 2 hours. While in all the above cases a delay was still discernible at the time blastulation and gastrulation occurred, plutei normal in appearance were formed from all the eggs, retardation being no longer observable.

Following irradiation of eggs with λ3,660Å slight retardation was noticeable only after a dosage of 40,000 ergs/mm², but even after a dosage of 74,500 ergs/mm² the retardation did not become conspicuous enough to measure accurately. No retardation was observable at the time of blastulation or thereafter, observations being made until the pluteus stage was reached.

In no case were eggs irradiated at these wave-lengths with less than the retarding dosage observed to cleave more rapidly than controls, the cleavage rate in such cases being equivalent to that of the controls.

Excystment time of Colpoda cysts (time elapsed from the moment the cysts are placed in an excysting medium to the exit of the animals from the cysts) was increased by irradiation with λ3,025Å, thus in a representative set of experiments a dose of about 3,000 ergs/mm² caused an increase in time of 50 per cent. excystment of about ¾ hour, a dose of 8,000 ergs/mm² an increase of 3¾ hours (time of 50 per cent. excystment of controls: 132.3 ± 5.9 min. in the experiments reported). A dose of 3,000 ergs/mm² at λ3,130Å, however, failed to increase excystment time, and ten times this dose caused an increase of only about 1/3 hour. Prolonged irradiation with λ3,660 even after dosages of 100,000 ergs/mm² had been given produced no increase in excystment time, the irradiated animals excysting at the same time as the controls.

[1] Giese and Leighton, SCIENCE, 81: 53, 1935.
[2] Taylor, Brown and Strickland, *Jour. Cell. and Comp. Physiol.*, 9: 105, 1936.

In no case in which conditions were properly controlled was there evidence of a decrease in excystment time when cysts were irradiated with dosages below the threshold dose causing increased time of excystment.

The results indicate that (1) while radiations of 3,130Å failed to produce visible effects or kill protozoans after prolonged exposures, when the dosage is sufficiently great, slight retardation of certain cell processes may occur. This can be demonstrated if the test material is sufficiently delicate. (2) The fairly large dosages of radiations of λ3,660Å had exceedingly slight or no retarding effects upon even the more sensitive cell functions here tested.

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THE PRODUCTION OF LYMPHOMATOSIS IN MICE OF KNOWN GENETIC CONSTITUTION[1]

LYMPHOMATOSIS, with or without a leukemic blood picture, has been observed in mice after painting the skin with 1:2:5:6-dibenzanthracene[2] and following the subcutaneous injection of sodium 1:2:5:6:-dibenzanthracene-9:10-endo-α:β-*succinate*.[3] An atypical leukemia followed the intrasplenic injection of 3:4-benzpyrene in a mouse of the S strain.[4] The chemical production of leukoses has been criticized because of the high spontaneous incidence of mouse leukemia and the alleged failure to adequately control the genetic factors.[5] We wish to record the appearance of lymphomatosis in mice of known genetic constitution that followed painting with methylcholanthrene.

The mice used were of the dilute brown strain developed by Little. They were obtained from the Roscoe B. Jackson Memorial Laboratory, where the strain has been followed for more than twenty-five generations. Leukemia has occurred rarely and never before the animals were eighteen months old.[6] Breeding females have a very high incidence of spontaneous mammary cancer.

Forty-eight mice were used. They were not allowed to breed. On November 1, 1937, when the animals were four to six weeks old painting was commenced. The material used was 0.5 per cent. methylcholanthrene in commercial benzene. It was applied with a No. 6 camel's hair brush. The site was changed with each painting so that the same area was not painted twice during the same month. Contiguous regions were not painted in succession. The order was: head, left hind leg, right hind leg, left foreleg, right foreleg, sacral region, abdomen, interscapular region, anterior thorax. Three mice died of infection before the fifty-third experimental day.

When the animals had received their tenth painting (sixty-ninth day) a subcutaneous inguinal mass was found in a female mouse. Three days later bilateral inguinal and axillary lymphadenopathy was present. The animal died on the seventy-fifth day of the experiment. At autopsy the axillary, inguinal, abdominal and tracheo-bronchial lymph nodes were greatly enlarged, attaining a diameter of more than 1 cm. The liver was pale. The spleen was large and gray.

Microscopically the architecture of the lymph nodes was obliterated. The nodes were filled with atypical lymphoid cells which were closely packed together. The cells were larger than normal lymphocytes. They had scanty basophilic cytoplasm and large, round, vesicular nuclei with prominent nucleoli. Mitotic figures were numerous. Capsular infiltration was noted. The normal structure of the spleen was lost. The pulp was replaced by cells similar to those found in the lymph nodes. The liver showed marked leukemic infiltration, particularly in the peri-portal areas.

Nine more mice, four females and five males, have subsequently developed the same picture. The disease is first noted as a cervical, axillary or inguinal lymphadenopathy which is bilaterally symmetrical in distribution. The mice die within two or three weeks of the onset and present more or less generalized lymphoid enlargement. Some of the nodes have measured more than 2 cm in diameter. Subcutaneous edema, ascites and hydrothorax have been found. The fluid is usually clear. Leukemic infiltration has been seen in lung, skin, coagulating gland, bladder, kidney and skeletal muscle. The myeloid cells of the bone marrow are replaced by lymphoid cells.

Blood studies have been done on two mice. The leucocytes numbered 90,000 and 139,000, respectively. A secondary anemia was present. The white cells were almost all of the lymphoid series. Many immature forms were seen.

Five skin tumors have been produced thus far (one hundred and third day), one of which is malignant. None of these animals have shown any evidence of lymphadenopathy.

No tumors have appeared in fifty control mice.

Although the experiment has not been completed, the production of lymphomatosis with a leukemic

[1] From the Department of Surgery, the University of Rochester School of Medicine and Dentistry. This investigation was aided by grants from the International Cancer Research Foundation and from Mr. Simon Stein.

[2] I. H. Perry and L. L. Ginzton, *Am. Jour. Cancer*, 29: 680, 1937.

[3] H. Burrows and J. W. Cook, *Am. Jour. Cancer*, 27: 267, 1936.

[4] W. A. Barnes and J. Furth, *Am. Jour. Cancer*, 30: 75, 1937.

[5] M. N. Richter and E. C. MacDowell, *Physiol. Rev.*, 15: 509, 1935.

[6] C. C. Little, personal communication.

blood picture seems to be significant in the dilute brown strain of mice. The general appearance of the animals is different from that observed in the rare cases that have occurred spontaneously in this strain.[6] The incidence, to date, is more than 20 per cent. and the time elapsed in the development of the lymphomatosis is one third of that required for the spontaneous disease to appear. Further studies are being undertaken to evaluate the many factors involved, and other strains of mice are being investigated in the same manner.

JOHN J. MORTON
G. BURROUGHS MIDER

A PARADOX IN THE ADAPTATION OF MARINE BACTERIA TO HYPOTONIC SOLUTIONS[1]

ACCORDING to Korinek[2] marine bacteria are distinguishable from freshwater or terrestrial species on a basis of their salt tolerance. This is in agreement with the observations of ZoBell and Feltham,[3] who found that less than 10 per cent. of the bacteria isolated from the sea at places remote from terrigenous contamination can multiply in nutrient freshwater media, and a smaller percentage of bacteria from freshwater sources multiply in undiluted sea-water media.

In studying the factors which influence the specific salt requirements of bacteria from heterologous environments, attempts were made to acclimatize marine bacteria to hypotonic solutions by gradually diluting the sea-water medium with each successive transfer of the cultures. Twelve recently isolated species were selected which would grow in nutrient sea-water broth but not in similar freshwater media. The media consisted of 0.2 per cent. each of Bacto-peptone, proteose-peptone and beef-extract and 0.025 per cent. of ferric chloride in either sea water, distilled water or various dilutions of sea water. The pH, incubation temperature (22° C.) and other experimental conditions were the same with the different kinds of media. At the beginning of the experiments all twelve cultures multiplied in 75 per cent. sea-water medium (75 parts of sea water diluted with 25 parts of distilled water). Seven of them grew in 50 per cent. sea-water medium, but none of them grew in 25 per cent. sea-water medium.

As soon as the turbidity of the 75 per cent. sea-water broth indicated good growth, a loopful of a dilute suspension of each culture was transplanted to 70 per cent. sea-water broth. If after 24 to 48 hours there was evidence of multiplication, this in turn was used to inoculate 65 per cent. sea-water broth, and so on seriatim, decreasing the concentration of sea water each time by 5 per cent. Under these conditions all twelve cultures were readily adapted to 45 per cent. sea water. Upon the next transfer, however, three of the cultures failed to show any signs of growth in 40 per cent. sea water, even after a week's incubation, although in higher concentrations of sea water they rendered the media turbid with growth in 24 to 48 hours. Therefore transplants of these fastidious cultures were made from 45 per cent. to 42½ per cent. sea-water medium, and in each successive medium the concentration of sea water was decreased by only 2½ per cent.

Most of the cultures could be acclimatized to 25-30 per cent. sea-water media, but below this concentration considerable difficulty and delay were encountered in making them grow, although the concentration of the sea water was changed by decrements of only 2½ per cent. After five months of almost daily attention four of the original twelve cultures were multiplying in freshwater medium containing no sea water. The lowest concentration in which the others grew may be summarized as follows:

2	cultures	in	5	per	cent.	sea	water
3	"	"	10	"	"	"	"
1	culture	in	17½	"	"	"	"
1	"	"	22½	"	"	"	"
1	"	"	25	"	"	"	"

In each case attempts to induce growth in the next lower dilution were negative, and the growth in the above media was very meager after 48 hours.

At this stage the parent stock cultures, which had been maintained in the refrigerator on sea-water agar during the five-month period, were reexamined. Microscopic inspection of stained smears revealed that the acclimatized cultures did not differ morphologically from their parent cultures. Paradoxically, though, it was found that all except three of the parent cultures multiplied when transplanted to freshwater medium and these three multiplied in 10 per cent. sea-water medium. Similar results were obtained with the original sea-water broth cultures, which had been maintained at room temperature since the beginning of the experiment, although the salt content of the medium had actually increased due to the evaporation of water. In other words, the old stock cultures were more euryhaline and better adapted to grow in hypotonic solutions than their progeny, which had been rejuvenated almost daily in attempting to gradually acclimatize them to lower salinities.

A repetition of the experiment with other recently isolated marine bacteria yielded similar results. In fact, tests on over a hundred different pure cultures of bacteria, which upon initial isolation from the sea

[1] Contributions from the Scripps Institution of Oceanography. New Series, No. 16.

[2] J. Korinek, *Centralbl. f. Bakt.*, Abt II, 71: 73, 1927.

[3] C. E. ZoBell and C. B. Feltham, *Proc. Fifth Pacific Sci. Cong.*, 3: 2097, 1933.

grew in sea-water medium but not in freshwater medium, revealed that after two to five years' maintenance in sea-water media virtually all of them would grow in freshwater medium.

At first this seems contrary to the observations of Kluyver and Baars[4] that bacteria become less adaptable to adverse environmental conditions during prolonged laboratory cultivation. Moreover, it is contrary to the accepted beliefs concerning the adaptability of organisms in general. However, there are several factors which must be taken into account in the interpretation of this apparent paradox. According to Rahn[5] it is established that physiologically young bacteria are more sensitive to adverse conditions than old ones. The frequent transfer of the cultures during the attempts to acclimatize them to hypotonic solutions tends to keep them physiologically young, while the stock cultures becomes senescent.

Data on the salt tolerance of bacteria from different strata of mud cores collected from the deep sea bottom lend credence to this "tolerance with senescence" theory. The majority of the bacteria found in the topmost few millimeters of sedimentary material where conditions favor their multiplication are typical marine species which grow in sea-water but not in freshwater media upon initial isolation.[6] However, in the deeper strata where the aerobic bacteria have probably been buried in a state of suspended animation for a long time lacking both oxygen and food for their multiplication, the majority of them grow equally well on sea-water and freshwater media. Similarly, the senescent bacteria from these deeper mud strata will grow over a wider temperature range than the physiologically young psychrophilic bacteria found in the topmost layers of mud.

It has been suggested that these bacteria require for growth certain allelocatalysts or accessory growth substances, which are present in sea water but not in fresh water. In an old culture, these substances may accumulate to such an extent that an inoculum therefrom may carry into a new culture an amount sufficient to promote growth, even though the new medium fails to contain the necessary substances. This, perhaps, is the reason for the greater tolerance of these senescent cultures to fresh water. This possibility, as well as others, is being investigated in order to account for the phenomena reported above.

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[4] A. J. Kluyver and J. K. Baars, *Proc. Koninklijke van Wetenschappen te Amsterdam*, 35: 1, 1932.
[5] O. Rahn, "Physiology of Bacteria," P. Blakiston's Son, Philadelphia, 1932.
[6] C. E. ZoBell and D. Q. Anderson, *Bull. Amer. Assoc. Petrol. Geol.*, 20: 258, 1936.

THE PROTEIN CONTENT OF MOSAIC TOBACCO[1]

The concentration of virus protein in tobacco infected with mosaic and the proportion of virus protein to normal proteins are data necessary to an adequate understanding of the synthesis of virus protein. According to Bawden and Pirie,[2] mosaic plants may contain five to ten times as much protein as normal tobacco, and according to Stanley,[3, 4] as much as 80 per cent. of the total protein of diseased tissue may be virus protein. Either an enormous accumulation of virus protein or an almost complete change of normal into virus protein has to be assumed. Such estimates are based, however, on the yield of protein obtained by extraction, and, especially with healthy plants, the extractable protein accounts for only a small fraction of the total nitrogen. On the other hand, Stanley is less concerned with the comparison of healthy and diseased tissues than with the examination of the diseased tissues as such. However, in spite of an increase in extractable protein in virus-bearing plants, a comparison of diseased and control plants made from the recent data of Stanley[3] appear to show no significant increase in total nitrogen due to the disease. With some strains of mosaic a decrease has occurred. This follows from the published data when the residual nitrogen in the press cakes is taken into account. For instance, in plants infected with common mosaic, the total nitrogen was 7.25 mg/g, while control plants contained 6.90 mg/g. Plants infected with aucuba mosaic contained 2.92 mg/g, as compared with the same control, thus indicating a substantial decrease.

The extraction of the protein, on the other hand, may have been incomplete. The quantities obtained from healthy plants are barely a tenth of the protein content of tobacco reported by Vickery and Pucher[5] from an extensive series of analyses, also on healthy plants. The highest yield recorded by Stanley shows 22 per cent. of the total nitrogen as protein in diseased plants, while the lowest yield was only 5 per cent. in control plants.

By applying the observation[2, 6] that virus protein is not attacked by crude trypsin, although normal tobacco proteins are hydrolyzed, it has been possible to develop a method of distinguishing between trypsin-resistant virus protein and normal proteins without resorting to extraction of the tissue.

[1] Food Research Division Contribution No. 362.
[2] F. C. Bawden and N. W. Pirie, *Proc. Roy. Soc.*, B 123: 274, 1937.
[3] W. M. Stanley, *Phytopath.*, 27: 1152, 1937. (Particularly page 1152 together with page 1155.)
[4] W. M. Stanley, *Jour. Biol. Chem.*, 121: 205, 1937.
[5] H. B. Vickery and G. W. Pucher, *Conn. Agr. Exp. Sta. Bull.* No. 324, 1931.
[6] L. F. Martin, H. H. McKinney and L. W. Boyle, SCIENCE, 86: 2234, 380–381, October 22, 1937.

In general, the method consists of determining total nitrogen and nitrogen soluble in 10 per cent. trichloracetic acid, the latter before and after digestion with commercial trypsin.

When corrected for the soluble nitrogen of the trypsin employed, the results are independent of the amount of enzyme used, although this should be fairly large in any case. The method permits the quantitative determination of crystalline common mosaic virus added to normal tobacco tissue.

Only a small amount of nitrogen is removed by water from healthy tobacco tissue; but about two thirds of the total nitrogen of the plant becomes soluble in trichloracetic acid solution after tryptic digestion. It seems probable that the material attacked by trypsin represents protein or protein-bound nitrogen. The amount of nitrogen rendered soluble in trichloracetic acid by trypsin acting on healthy tobacco tissue also corresponds well to the protein content of such tissue as found by Vickery and Pucher.[5] About 20 per cent. of the nitrogen of the normal plant is not rendered soluble by trypsin, however. We are not yet certain as to the character of the residual nitrogen, but in the diseased plant this amount is increased by the quantity of virus protein present. It is apparent that substances other than virus protein may be included in the trypsin-resistant fraction, but all the virus protein is included. The results obtained therefore represent an upper limit for the quantity of virus protein present.

Results were obtained by this method on three varieties of tobacco and three mosaics, as shown in Table I. These combinations were selected because of differences in the severity with which the mosaics attack the varieties in question. Wisconsin-Havana tobacco (No. 1, 6) with common mosaic developed a severe light green mottling, with yellow mosaic (No. 5) a severe yellow mottling, and with mild mosaic a mild light green mottling (No. 3). Common mosaic on the other hand did not induce symptoms in Ambalema tobacco (No. 2), although the juice was very infectious for more susceptible varieties. Tobacco 448A (No. 4) when inoculated with common mosaic virus developed no symptoms. The virus increased in the young plants, but at a later stage there was no detectable virus in the leaves used for protein determinations.

The following conclusions are drawn from the data in Table I:

TABLE I

No.	Tobacco variety	Mosaic	–A– Total N mg./g.	–B– Soluble N mg./g.	–C– Protein N and undig. N mg./g.	–D– Digestible protein N mg./g.	–E– Undigestible N mg./g.	–F– Virus-Protein N mg./g.	–G– Proportion of virus protein to total protein per cent.
1	Wis.-Hav.	Common	5.58	0.37	5.21	2.74	2.47	1.10	29
1c	Wis.-Hav.*	.....	5.53	0.62	4.91	3.54	1.37	...	..
2	Ambalema	Common	5.65	0.86	4.79	3.64	1.15	0.32	8
2c	Ambalema*	.....	5.65	0.99	4.66	3.83	0.83	...	..
3	Wis.-Hav.	Mild	6.42	0.86	5.56	3.78	1.78	0.18	5
3c	Wis.-Hav.*	.....	6.72	0.71	6.01	4.41	1.60	...	..
4	448A	Common	5.84	0.81	5.03	3.86	1.17	– 0.08	0
4c	448A*	.....	6.64	0.77	5.87	4.62	1.25	...	..
5	Wis.-Hav.	Yellow	5.83	0.88	4.95	3.52	1.43	– 0.06	0
6	Wis.-Hav.	Common	5.01	0.48	4.53	2.66	1.87	0.38	12
5–6c	Wis.-Hav.*	.....	5.06	0.55	4.51	3.02	1.49	...	..

* Healthy controls.

Seed and plant material of Ambalema and 448A supplied by E. E. Clayton.

(1) The total nitrogen of the plants (Column A) was found to be very little changed from the normal irrespective of the severity of the disease.

(2) The total protein (Column C) seems also to have undergone little if any change but the accuracy of the results is probably not high enough to demonstrate small variations, since they are calculated by difference. This suggests that the virus protein is produced at the expense of the normal protein, though not necessarily directly from it.

(3) In the case of the common mosaic the trypsin-resistant protein (Column F), regarded by us as virus protein, exists in smaller proportion than has been supposed previously. The amount of resistant protein was found to be greater in a susceptible variety of tobacco than in those generally considered less vulnerable. We have no proof at present, however, that the yellow mosaic virus is resistant to trypsin.

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THE EFFECT OF 1,2,5,6-DIBENZANTHRACENE ON THE GROWTH AND RESPIRATION OF YEAST

RECENT papers have reported a stimulating effect of methyl cholanthrene on the growth of yeast[1] and of methyl cholanthrene and 1,2,5,6-dibenzanthracene on the growth of *Escherichia communior*.[2] In view of these reports it seems desirable to give a preliminary account of our own experiments.

Employing the rocker-tube yeast growth technique previously used in this laboratory[3] we have found that the addition to yeast suspensions of crystals of 1,2,5,6-dibenzanthracene in the proper concentration (9×10^{-4} molar) causes an increase in yeast proliferation of approximately 50 per cent. Quantities both larger and smaller have less effect, and four times this amount is sufficiently toxic to inhibit growth. Similar quantities of non-carcinogenic anthracene were without effect.

In the respiration experiments, using the Warburg technique as previously employed by us,[3, 4] the addition of the crystalline hydrocarbon gave somewhat erratic results. Hence, a colloidal suspension prepared by the method of Boyland[5] without gelatin was substituted. Under the conditions of the experiments high concentrations (3×10^{-4} molar) of 1,2,5,6-dibenzanthracene stimulated respiration, while lower concentrations depressed it and the amount of depression increased with decreasing concentration, there being apparently an optimum inhibiting concentration. It is significant that 1,2,5,6-dibenzanthracene and 3,4-benzpyrene have been found to depress the respiration of brain, spleen and liver, and that the lower concentrations were the more effective.[6]

Owing to the difference between the growth and respiration techniques it is impossible to compare the concentrations effective in the two types of experiments, but it is apparent that concentration is important in determining the effects of 1,2,5,6-dibenzanthracene on yeast metabolism. Experiments are in progress to correlate the effective concentrations, and the work is being otherwise extended.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PROJECTION READER FOR FILMSTATS

SINCE Seidell's articles[1] on the photographic reproduction of scientific literature have appeared, the use of 35 mm film in library service has increased: but the attendant problem of a satisfactory reading device does not seem to have been finally solved.

There are several low-cost direct readers on the market, but their field of vision is limited and their magnification is so low that they cause excessive eye strain. The projection readers that have come to the writers' attention are expensive and not always convenient to operate.

Any institution that has a Leica, Contax or other type of projector for 35 mm film can easily and cheaply build a satisfactory projection type of reader and take advantage of the valuable facilities that Science Service offers in the photographic reproduction of scientific literature. The only accessories required are a 1½ inch 45° prism (a small mirror can be substituted), a 6″ × 8″ plate glass mirror and a 10″ × 12″ ground glass plate. Any carpenter can build the necessary small table and the details of the assembly are clear from Fig. 1.

The projector, placed on a shelf under the table top, passes the light beam through the prism which directs the beam at right angles to the 6″ × 8″ mirror, placed near the rear edge of the shelf and fixed at an angle of about 59°. This mirror directs the image upward to the 10″ × 12″ ground glass reading plate, housed in a lectern-like case on top of the table, at an angle of about 45°, thus giving an easy reading inclination to the image. The rest of the table top to the right is convenient for taking notes.

The projector is near the right hand for ease in focusing and moving the film strip, while a switch is placed above the projector on the table edge.

The total light path from the front of the lens of the projector, through the prism, to the mirror and up to the ground glass reading plate, should be an inch or two longer than the shortest focal distance of the projector, thus allowing a little leeway in focusing the image. In this case, using an old model Leica projector, the minimum focal distance was 39 inches and the light path was made to equal 41 inches. The magnification is about 13 times, thus giving an image slightly larger than the original photographed page.

Without a film in the projector the reading plate can be used for retouching negatives, tinting trans-

[1] Dodge and Dodge, *Ann. Missouri Bot. Garden*, 24: 583, 1937.
[2] Goldstein, SCIENCE, 86: 176, 1937.
[3] Norris and Kreke, *Studies Inst. Divi Thomae*, 1: 137, 1937.
[4] Cook, Hart and Joly, *Proc. Soc. Exptl. Biol. Med.*, in press.
[1] Atherton Seidell, SCIENCE, 80: 70–72, July 20, 1934; *ibid.*, 184–5, August 24, 1934; *ibid.*, 174–6, February 15, 1935; *Jour. Chem. Ed.*, 12: 415–18, 1935.
[5] Boyland, *Lancet*, 223: 1108, 1932.
[6] Pourbaix, *Compt. rend. soc. biol.*, 110: 1015, 1932; 112: 1222, 1933; 113: 930, 1933; 115: 1738, 1934.

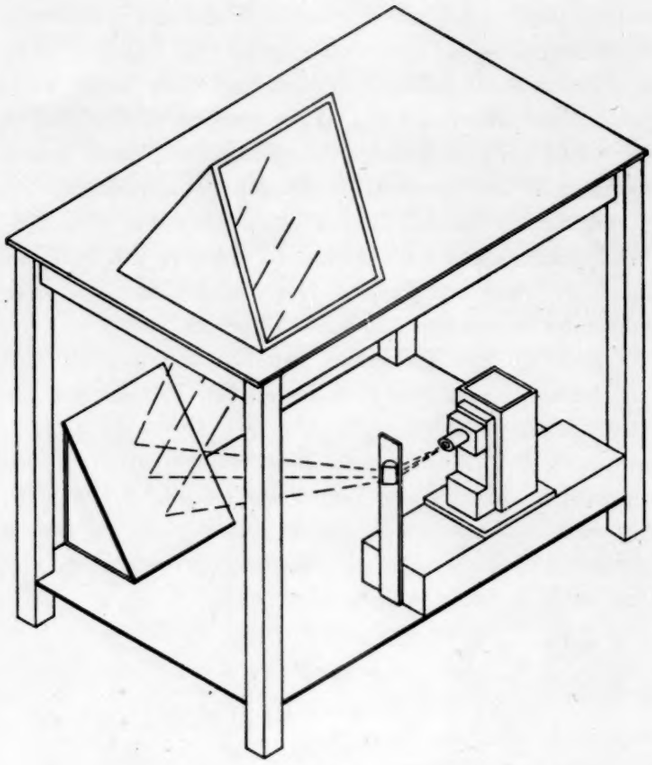

FIG. 1

parences or examining x-ray films. The device has given satisfactory service, and the image is bright enough ordinarily to be read in a lighted room.

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SCHOOL OF TROPICAL MEDICINE
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A METHOD OF DETERMINING ASCORBIC ACID IN SKIN[1]

SKIN is unsuitable for treatment by the customary procedures for the extraction of vitamin C from tissues.[2] A method has been devised based upon the ability of collagen to soften and swell when heated in acid solutions. The samples of skin are weighed, minced with scissors and placed in large test-tubes with 10 cc of a solution containing 8 per cent. acetic[3] and 2 per cent. metaphosphoric acid. The tubes are drawn out with a blast lamp and sealed after evacuation of the air. They are then placed in boiling water for twenty minutes, opened immediately upon removal, and the contents transferred to a second tube for centrifugalization. After the supernatant fluid has been decanted, the sediment, consisting of softened pieces of skin, is broken up in the tube with a glass rod and washed with 2 cc of 8 per cent. trichloroacetic- and 2 per cent. metaphosphoric-acid mixture and again centrifugalized. This procedure is twice repeated. The pooled supernatant fluids are then titrated with 0.05 per cent. 2,6-dichlorophenolindophenol solution according to the method of Bessey and King. The tables illustrate the agreement between samples and the recovery of added vitamin C.

TABLE I

GUINEA-PIG SKIN MINCED AND SAMPLED IN TRIPLICATE FOR DETERMINATION OF VITAMIN C

Sample of skin	Ascorbic acid
1.0 gm	mg/gm
1	0.0397
2	0.0404
3	0.0404
1*	0.0007
2*	0.0007
3*	0.0000

* 4th washing.

TABLE II

GUINEA-PIG SKIN MINCED AND SAMPLED IN QUADRUPLICATE FOR THE DETERMINATION OF VITAMIN C IN THE PRESENCE OF ADDED ASCORBIC ACID

Sample of skin	Ascorbic acid added	Ascorbic acid determined	Added ascorbic acid recovered
0.5 gm	mg	mg	mg
1	0	0.0235	0
2	0	0.0235	0
3	0.100	0.1134	0.0899
4	0.100	0.1098	0.0863
–	0.100	0.0915	0.0915

The method has been in constant use for the past year and has given consistent and reproducible results.

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[1] From the Division of Laboratories and Research, New York State Department of Health, Albany.

[2] O. A. Bessey and C. G. King, *Jour. Biol. Chem.*, 103: 687–698, 1933.

[3] Trichloroacetic acid is broken up on heating and can not be used at this step. The digested skin is later washed with trichloroacetic acid to precipitate the proteins.

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